Computational Modeling of Hall Thruster Erosion

Completed Technology Project (2011 - 2015)

Project Introduction

Hall thrusters are being developed by NASA, DOD, and industry to meet a variety of on-board space propulsion needs. Hall thrusters have been operated successfully for many years on Russian/Soviet spacecraft at a power of about 1-2 kW; present day thrusters are designed for operation at 3.5-4.5 kW, and there is growing interest in extending the power range up to 50 kW and higher. A very important life-limiting failure mechanism for all of these Hall thrusters is erosion of the discharge channel walls due to ion impact. Ions created in the discharge process impact onto the walls and cause sputtering of the wall materials, typically made of ceramics such as boron nitride. In the design of Hall thrusters for many missions, lifetime is as important as propulsion performance. Recent NASA investigations aimed at advancing the state of the art have been tightly focused on extending mission lifetime by modifying standard Hall thrusters, providing propulsion solutions for cost constrained missions [1]. Hence, there is a great need to understand, quantify, and predict the erosion processes in detail. In comparison to basic research on thruster performance, however, relatively little progress has been made in modeling and accurately predicting the channel erosion of Hall thrusters. The overall goal of the proposed research effort is to construct and validate a computer model to predict Hall thruster discharge channel erosion profiles. Validation will be performed through the work done on NASA's HiVHAc project and the University of Michigan.

Anticipated Benefits

There is a great need to understand, quantify, and predict Hall thruster erosion processes in detail. In comparison to basic research on thruster performance, however, relatively little progress has been made in modeling and accurately predicting the channel erosion of Hall thrusters. Hall thrusters are being developed by NASA, DOD, and industry to meet a variety of on-board space propulsion needs. Hall thrusters have been operated successfully for many years on Russian/Soviet spacecraft at a power of about 1-2 kW; present day thrusters are designed for operation at 3.5-4.5 kW, and there is growing interest in extending the power range up to 50 kW and higher. A very important life-limiting failure mechanism for all of these Hall thrusters is erosion of the discharge channel walls due to ion impact.

Project Image Computational Modeling of Hall Thruster Erosion

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

Space Technology Research Grants

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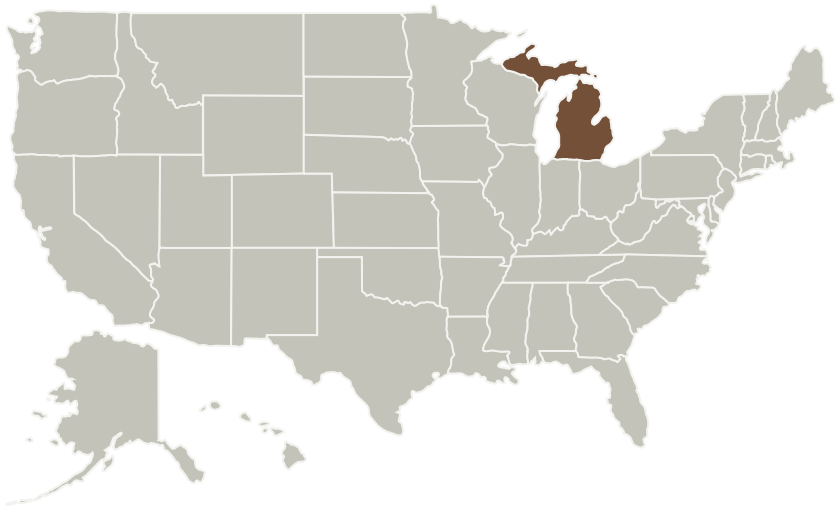
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Michigan-Ann Arbor	Supporting Organization	Academia	Ann Arbor, Michigan

Primary U.S. Work Locations
Michigan

Project Management

Program Director:
Claudia M Meyer

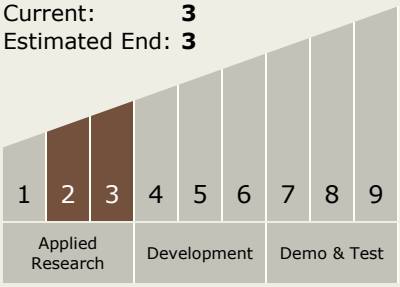
Program Manager:
Hung D Nguyen

Principal Investigator:
Iain D Boyd

Co-Investigator:
Brandon J Smith

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.2 Electric Space Propulsion
    - TX01.2.2 Electrostatic

Images

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Project Image Computational Modeling of Hall Thruster Erosion
(https://techport.nasa.gov/image/1733)

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html